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Environmental Health Center
Cincinnati, Ohio

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SOIL ABSORPTION SYSTEMS IN HOUSEHOLD SEWAGE DISPOSAL*

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A septic tank-soil absorption system under favorable environmental circumstances, and if properly designed and constructed, is a satisfactory method of residential sewage disposal. Under unfavorable environmental circumstances and if carelessly designed and constructed, such systems are a source of embarrassment and expense to the home owner as well as a problem to the authorities.

Individual household sewage disposal as a distinct process originated with the discovery and the patenting of the septic tank in 1881. In the United States the household septic tank dates back to about 1883. Soil absorption systems have apparently resulted from a gradual evolution from a privy, to a cesspool, to a seepage pit and to a trench type system as we know it today, with little recorded historical background.

Since that time the use of the septic tank-soil absorption system has spread widely, until today there are some four and one-half million systems serving some seventeen million persons in the United States. With the increase in fringe area or suburban development and with the increasing availability of electricity and transportation in rural areas, it is quite likely that there will be continuing and increasing use of the individual systems. For example, in recent residential construction, it is estimated that 40 per cent of the homes being built with federal mortgage insurance assistance are dependent upon individual systems for sewage disposal.

In an effort to improve our knowledge and understanding of these systems, the Environmental Health Center has been conducting a broad study program under

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the joint sponsorship of the Public Health Service and the Housing and Home Finance Agency. Two reports on these studies entitled "Studies on Household Sewage Disposal Systems," Part I and Part II, have been published and are available from the Environmental Health Center or from the U. S. Government Printing Office.

Environmental Considerations:

The objective of the individual household sewage disposal systems is the safe and convenient disposal of household wastes, in a manner not hazardous to the health of the family, or the community, and without nuisance.

Such systems are, of course, used only in areas in which public sewers are not available, in rural or fringe areas or in suburban subdivision developments which are not yet reached by public sewers. For rural or scattered fringe area installations, consideration of the environment with respect to the individual home is usually sufficient. However, when there is a concentration of installations, such as in subdivision development, careful consideration should be given to the environment with respect to the development as a whole, as well as to the individual homes. For instance, in areas in which either ground water or impervious soil lies at shallow depths, a few scattered systems may operate successfully. However, with numerous installations, such as in subdivision developments, experience has shown that such areas often become trouble spots. The result is a raised local water table, surface seepage, sewage backing up into the home, odor nuisances, etc. Development of such areas with individual sewage disposal systems should be avoided.

Components of a System:

Before discussing soil absorption systems in detail, I would like to review briefly the make-up of the entire system. The system starts, of course,

with the house sewer. There may be one or more sewers, depending on the house and disposal system layout. In some schemes the septic tank may receive toilet wastes or bathroom wastes only, with discharge of other wastes to separate absorption lines. Kitchen wastes are sometimes conducted to a grease trap, following which they may be discharged to the septic tank, by-passed around the tank to the soil absorption system, or discharged to a separate soil absorption line. For common practice, however, is to discharge all household waste through one sewer to the septic tank and soil absorption system. Most modern recommendations do not include a grease trap for the residential system, although it is commonly recommended for restaurant, road house, institution, and other installations where sizeable amounts of grease are discharged, and where the trap may receive the necessary maintenance.

Although the cesspool is still used in some localities, it has become pretty well recognized as a source of difficulty in anything but the most porous soils. It is not recommended nor approved in many States and local areas. The usual cesspool is a well, the lower section of which is lined with open joint stone or brick, whereas the upper section is of tight joint construction, drawn in to support a manhole or slab top. Raw household waste enters near the top and the liquid is supposed to pass through the open joints into the soil.

Most residential systems consist of a septic tank followed by a soil absorption system. The septic tank serves as a settling, digestion and storage tank, essentially prepares the sewage for further treatment and absorption in the soil, or in some cases, for treatment on subsurface filters. The combination of the three functions in one device, the septic tank, is perhaps

not the best technical arrangement, but it has many merits from the practical standpoint of simplicity in construction, ease of maintenance and low cost. Structurally, it consists of a watertight chamber equipped with sewage inlet and outlet appurtenances arranged to retain floating matter and minimize short-circuiting of sewage through the tank. Provision is made for passage of gases from the tank and soil absorption system to the house stack. Means of access to the tank interior for inspection, gaging and removal of sludge and scum is usually provided. You are aware of course that the septic tank is not complete treatment, and that the effluent is still a health and nuisance hazard.

The system for absorption of septic tank effluent into the soil may take various forms. Most commonly, where tests show that shallow soil at a particular site promises adequate absorption, a system of open joint or perforated conduits laid in gravel in shallow trenches serves to distribute the effluent to the soil. Where two or more trenches are used, a distribution box serves to divide the tank effluent into portions discharged to each trench. If tests show the upper soils to be unsuitable for the shallow trench type of system, but also by test, that there is opportunity for absorption in underlying layers, a seepage pit may be used as the means for distribution of effluent to the soil. A seepage pit is a porous-sided well, similar in construction to a cesspool, the difference being that the seepage pit receives septic tank effluent while the cesspool receives raw sewage. Since seepage pits penetrate the deeper soils they can constitute a greater hazard to pollution of ground waters than the shallow type system. In all cases the local environmental factors should be taken into consideration, regardless of the type of system being considered.

Where neither upper nor lower soil strata offer absorption possibilities, the customary alternative, if compatible with environmental factors, is discharge through a subsurface sand filter bed or sand filter trench to a surface watercourse. Such filters have open joint or perforated pipes laid in gravel above and below the sand filter to distribute the effluent and to collect the filtrate for discharge to the surface watercourse. The public health aspects of such discharge must be considered of course and special authorization from the health department for each such system is usually required.

Common Problems and Difficulties:

Concerning problems and difficulties in practice, the most frequent complaint over the country is seepage of sewage to the ground surface. This can result from steep slopes in tile lines or from failure to design on the basis of a proper investigation of the soil. In some cases, however, the trouble is not the soil absorption system, but failures elsewhere which result in clogging the absorption system. Failures, say at the septic tank, either through faulty design or construction, or simple neglect of services, may go unnoticed until consequent damage to the soil absorption system reaches the point where sewage seeps to the surface, or backs up in the house. In any case the result is a clogged absorption system for which the only correction now known is relocation in fresh ground. This is expensive at best. It is obvious that on the usual residential lots the opportunities for repeated relocation in fresh ground are limited.

One of the major sources of trouble is neglect of maintenance. Some cleaners claim that in over 50 per cent of their cleaning jobs, they are called in after sludge accumulations have exceeded tank storage capacity,

and spillovers have clogged the absorption system. This is not necessarily any deliberate neglect by the home owner. It has been our experience during field inspections that the householder is usually uninformed as to the location of his facilities, what they are, and what he should do to maintain them. We found no lack of household interest, however, and in our opinion, many difficulties will disappear when the householder is given the necessary information. There is a leaflet, "Septic Tank Care," prepared by the Division of Sanitation of the Public Health Service, available from that office, or in quantity from the Superintendent of Documents, Washington, D. C., which should be helpful. The leaflet describes briefly the system and functions, provides guidance on maintenance, and space for a layout sketch of the system and for a record of servicing. The amount of attention required in these systems is very little actually, but too often the householder is left unaware of any responsibilities until sewage backs up and an expensive relocation ensues.

Absorption System Design Factors:

Now coming to the soil absorption system in detail, the all-important criterion for design is the rate that any particular soil will absorb effluent. Just how important this factor may be can be seen from a comparison of the amount of water a soil is normally required to absorb and the amount we expect it to absorb under conventional absorption field designs. The average rainfall of the United States is in the magnitude of from 30 to 50 inches per year with extremes ranging from 6 to 150 inches. Part of this rainfall is lost in surface runoff. The remainder, in the magnitude of 20 to 40 inches, with a maximum of possibly 100 inches, must be absorbed by the soil. As compared to these figures, the amount of water which is applied to and which must be absorbed by the soil of a disposal field, based on current design practice, ranges from 200 inches

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in the less absorbent soils to around 1,000 inches annually in the more porous soils. In extreme cases encountered in the field, amounts of over 2,000 inches were being applied. In other words, the soil of a disposal field is expected to absorb from 10 to 100 times more water than the same soil is required to absorb under normal rainfall conditions. This tremendous loading indicates that our problem is a major one from this viewpoint alone, without the complicating influence of soil clogging factors which we know exist under sewage or effluent dosing conditions.

The general problem, as far as the soil absorption system is concerned, is how to determine the size or the amount of soil absorption area to provide for any specific system. The answer to this problem may depend on a number of factors such as: the quantity and composition of the waste to be disposed of; the climate of the area; the absorption characteristics of the soil and the clogging characteristics of the effluent.

Quantity and Composition of Wastes:

The wastes from individual homes vary considerably in quantity and composition, depending on family size, living habits and other factors peculiar to the particular home. For example, the water consumption in a group of homes which we studied averaged 39 gallons per person per day in winter and 49 in summer. In the same group the variation was from 8 to 150 gallons per person per day in winter and 8 to 226 in summer. The character of residential waste is influenced by individual practices in the use of soaps, detergents, garbage grinders, washing machines, and sometimes, water softening units. Changes in occupancy introduce variation. As a consequence, the number of resident persons is losing favor as a yardstick of design load and in its place the number of bedrooms is considered to be a

better indication of the load potentiality of a home, particularly since it includes house capacity for temporary additional loads, such as weekend or overnight guests. It is of interest that small homes, that is, two-bedroom homes, tend to have larger person-per-bedroom occupancy than three-bedroom homes, and the three- larger than the four-bedroom home. Similarly, the larger water consumption per-person develops in the small home, and decreases toward the larger homes. It follows from this that unit loadings for the small home would be larger than those of the larger homes. It is necessary to take such variability into account because although averages may be useful in reflecting trends, the final application must result in designs which will serve most, if not all, of the individual cases.

Climate:

Climate may influence size of system as it influences the amount of moisture that can be removed from the soil by evaporation and by plant use. The amount of water evaporated from the soil and used by plants ranges from a few inches to over two hundred inches annually, depending on climate and on plant type. Warm climates with short winters and long plant growing seasons favor high moisture losses and such plants as alfalfa, clovers, and other deep rooted plants favor high moisture losses. Areas in which the rainfall is low and the potential evapo-transpiration is high, such as in the south-western part of the country, can probably get by with smaller absorption areas than northern areas where rainfall is as great or greater than evapo-transpiration losses over a large part of the year.

Soil Absorption Characteristics:

Probably the most important single factor influencing the size of system is the absorption characteristics of the soil. One of the basic problems in

the study of soil absorption systems is to devise ways or means to estimate or to measure the water absorption characteristics of a soil.

I would like to point out here that this is also a problem which concerns many others besides those interested in sewage disposal. Agricultural workers have been interested and have worked on the problem for years, particularly in relation to irrigation and to soil drainage, and the problem is still a long way from solved. However, there have been methods and aids developed which are of great help. There is also published soil literature available in many areas from which considerable information about the absorption characteristics of the soils of specific areas can be obtained. Both the U. S. Department of Agriculture and the various State Agricultural Experiment Stations publish this type of information and it is usually available on request. Probably the most valuable sources of information are the soil survey reports. These reports generally cover an area about the size of a county. They consist of a detailed soils map and an accompanying description of each soil type. Unfortunately actual percolation rate values are seldom given, but at least the general suitability of a soil for absorption fields may be interpreted from such reports. This type of information may be of particular value in planning the location of large housing areas.

Another means by which considerable information about water absorption characteristics may be obtained is by a close visual inspection of the soil. The value of such an inspection of course depends on being able to recognize pertinent details and clues, but this does not necessarily require a trained soils man. Anyone willing to do a little digging and looking can learn to recognize significant clues in short order. The main clues to look for are soil texture, soil structure and soil color.

Soil Texture:

Soil texture, or the relative proportion of sand, silt and clay in the soil, is probably the most common clue. The size of the soil particles govern the size of the soil pores which in turn directly govern the amount and the rate of water absorption. The larger the soil particles the larger are the pores and the faster is the rate of absorption. Soil texture can be judged best by the feel of the soil when it is wetted and rubbed between the fingers. The lighter or sandier soils have a gritty feel; silt type soils have a floury feel; the heavier clay soils have a slick feel. However, the use of texture as a clue to absorption qualities has its limitations. It is mostly reliable in the sandy range of soils. In the heavier type soils, which contain appreciable amounts of silt or clay, we must look for additional clues, such as soil structure.

Soil Structure:

Soil structure may be described as the tendency for the individual textural particles of a soil, particularly the clay particles, to aggregate or group together and form secondary particles of larger size which are more or less stable to wetting and to physical breakdown. Such secondary particles, rather than the textural particles, then tend to govern the size and distribution of pores and in turn the absorption properties. Soil structure can be recognized easily by the manner in which a clod or lump of soil breaks apart. If a soil has a developed structure, a lump will break with very little force along well-defined cleavage planes and into uniform sized and shaped units. On the other hand, if a soil has no structure, a lump will require considerable force to break it apart and when it breaks it will do so along irregular surfaces. Occurence of structure in a soil is a good

indication that the soil will have more favorable absorption characteristics than a similar soil without structure.

Soil Color:

The final and one of the most important clues to soil absorption characteristics is soil color. Relatively bright uniform reddish-brown to yellow colors throughout a soil profile indicate that there have been favorable oxidation conditions and that there has been free alternate movement of water and air in the soil. Such conditions favor desirable moisture absorption properties. At the other extreme, on the basis of color, are soils which are light gray throughout the top soil and dull drab and mottled in the subsoil. Such conditions indicate a lack of oxidation and a very restricted movement of air and water. These soils are quite likely to have unfavorable moisture absorption properties.

Again, as with the soil survey reports, visual inspection of a soil will aid in appraising the general suitability of soils for absorption fields, but for design data it will still be necessary to turn to some direct method of measuring water absorption rates of different soils.

Percolation tests:

In the sewage disposal field, the work of Henry Ryon in the 1920's has provided a useful tool for estimating soil moisture absorption rates. Ryon developed and put into use a percolation test by which he measured the rate that a soil would absorb clear water. Then, from a study of systems which had failed after some twenty years of operation, he also developed an empirical relationship between this clear water rate and the rate that the soil could be expected to absorb septic tank effluent. It is this test and empirical relationship, or slight modifications thereof, upon which most of the tests and design specifications being used today are

patterned. In this connection, from a review of specifications of control agencies, it appears that testing of water absorption capacity of the soil by a percolation test, and design of the system size on that basis, is not applied as widely as it should be.

The Ryon type test as generally run involves digging a one-foot square hole to the anticipated depth of trench bottom, filling the hole with at least six inches of water and observing the time required for the water to seep away. Some modifications require that if the soil is dry that the test be repeated, and some require that the rate of fall of the last inch of water be considered the percolation rate. In any event, specifications in general are loose and there appears to be a wide latitude for improvement and standardization of the test.

As one of our major efforts in the soils studies at Cincinnati, we have examined the Ryon type test experimentally in a wide variety of soils. As a result of the studies we are suggesting the following modifications in percolation test procedure: (1) substitute a four-inch auger hole for the laboriously dug twelve-inch square hole; (2) saturate the soil more completely by a standard procedure; and (3) use the minimum observed percolation rate for design instead of the average or some initial rate.

The first modification, the use of a four-inch auger hole, is justified since no significant differences were observed in the rates measured in the different sized holes in the same soils. There was as much variation between rates measured in replicates of the same sized holes as there was between the different sized holes. At first thought, the use of a small auger hole may appear to be a minor change, but it is a potentially important one from the viewpoint of the person who makes the test. The auger hole can be

prepared with a fraction of the time and labor, and requires a fraction of the volume of water to make a test. For one filling of a test hole, the four-inch auger hole requires only one-twelfth the volume of water required for the twelve-inch hole. This saving of water alone can be quite a consideration in cases where water must be transported to the site.

The saving in time and labor and in water can be invested profitably in making replicate tests in an area. Due to soil variability, a single test is often useless in estimating the absorption characteristics of an area even as small as 100 foot square. Six tests spaced uniformly over such an area are needed to obtain a reliable estimate.

Soil Saturation:

The second suggested modification, to saturate the soil more completely, is necessary in order to obtain consistent results regardless of the prior soil moisture conditions and regardless of the time of year that the test is made. Such saturation is desirable also in order to approximate soil conditions that will prevail in the absorption field. Anyone who has made a percolation test is familiar with the decrease in percolation that takes place during a test. The magnitude of this decrease and the length of time over which the decrease continues depends upon prior soil moisture conditions and upon the type of soil. The decrease will be more pronounced if the test is started in a dry soil and is likely to be more pronounced and will take place over a longer period of time in clay type soils. We have made a rather detailed study of this percolation rate decrease in several soil types in order to judge its practical importance.

Percolation tests were conducted at each site over a two-day period. On the first day, a test was made in a conventional Ryon test manner. The

percolation test holes were then kept filled with water and soaked overnight and the percolation test repeated on the second day.

The results of one such series of tests in a Rossmoyne soil exemplifies the importance of complete saturation. The site, if considered on the basis of the Ryon run, had a percolation rate of 44 minutes per inch and would be considered acceptable for an absorption field. Approximately 200 square feet of absorption area per bedroom would be required as judged by the Joint Committee on Rural Sanitation tables. On the basis of the wet run the percolation rate was 66 minutes per inch which would make the site unacceptable.

The latter case agrees with the performance of systems operating in this soil type. Of several systems inspected in the vicinity not one was considered as satisfactory by the home owners. One system, about five years old, inspected in detail, having approximately 300 square feet of absorption area and receiving toilet wastes only from one adult and two children, was found to be completely flooded and had serious surface seepage. Inspection of the system was made during August when conditions in general, high temperatures, high evapo-transpiration, etc., should have been most favorable for successful operation.

Improvement of the percolation test and thus securing slower rates immediately raises the question of the validity of using such rates for design of absorption fields on the basis of the present allowable loading rate tables. The slower rates obtained by the modified test will ofcourse require larger absorption areas than rates obtained by the older standard tests. Such a design will be or the safe side at least, so that for the time being all we can say is that the modified test rates can be safely used with present tables.

However, it is desirable to develop new and additional percolation rate-allowable sewage loading rate tables for a number of reasons. First, of course, the relationship may be different when a more rigidly controlled test is used for measuring percolation rates. Secondly, the relationship may and probably does vary with different soil types. The empirical relationship given by Ryon was developed under the limited soil and climatic condition occurring in New York; and furthermore, it was developed with a limited amount of data. An entirely different relationship may exist under midwest soil conditions, for example, where the soils tend to be deeper. Thirdly, the relationship may vary with different sewage characteristics. Obviously, the Ryon relationship was developed under sewage characteristics prevailing at that time. With the increasing use of home garbage grinders, use of automatic washers, use of detergents to replace soaps, etc., the sewage characteristics may be somewhat different today.

We are at present getting a field study under way with the cooperation of a number of local public health engineers and sanitarians over the country to develop new relationships.

Clogging Characteristics of Effluent:

The last major factor which may influence the size of system is the characteristics of effluent which cause soil clogging and reduce the absorption capacity of a soil. From agricultural soils experience we can consider soil clogging in three categories: (1) physical clogging, (2) biological clogging and (3) chemical clogging. Septic tank effluent is a physical, biological and chemical complex and may contribute towards all types of clogging.

The physical type of clogging is obvious: it may result from the physical plugging of the soil pores by the solid particles in the effluent.

Biological clogging, which is a common problem in agricultural water spreading work, may result from plugging of pores by biological bodies and by-products, or it may result from the biologic activity destroying or altering the soil structure. Actually, from experimental studies, it appears that biological activity does not cause soil clogging under effluent loading but instead it tends to reduce clogging that might be caused by other factors. Laboratory soil cores packed with a variety of soils and dosed with effluent over a three month period clogged in proportion to the amount of suspended solids in the effluents. After a few weeks of dosing, biological activity appeared to take effect, and the rate of clogging was reduced. Also, studies involving the application of normal and of disinfected effluent to soil cores resulted in a more rapid rate of clogging by the disinfected effluent, confirming the observation that biological activity tended to reduce the rate of clogging. Apparently digestion of solid materials in the effluent takes place in the soil and results in a net decrease in the clogging effect of the effluent.

The third type of clogging, chemical clogging, is a common agricultural soils problem in the western part of our country, particularly under irrigation conditions. The classic example is the "black alkali" soils that develop in some areas as a result of irrigating with water high in sodium. For this reason water quality has to be carefully controlled. It is generally considered that waters containing 50 per cent or more of the total cations (sodium, calcium, magnesium, and potassium) as sodium are potentially harmful to the water absorption characteristics of the soil. Even on sandy soils, waters of 85 per cent sodium or higher are likely to make soils impermeable after prolonged use. There are some indications that potassium may have similar effects.

The chemical quality of effluent will tend to vary with the water supply so that the sodium clogging may depend on the quality of water used. However, Wilcox has reported that there is a tendency for salt concentrations of sewage treatment plant effluents (primarily from Imhoff tanks) to be at least twofold greater than those of the water supply, and further, that the concentration of sodium in many of the effluents was disproportionately high. On the basis of this information, it appears that the possibility of effluents causing sodium clogging may be a problem for general consideration.

In our experimental study of the effluent sodium clogging influence, the relative amount of sodium to calcium was modified by adding gypsum to the effluent. It was found from core dosing studies that soils having a well-developed structure tended to maintain the structure and clog less under the calcium fortified effluent dosage than with normal effluent dosage. In single grained soils, with no apparent structure, there was no difference in the rate of clogging between the fortified and normal effluent dosed cores. Some proprietary septic tank "cleaning" compounds contain caustic soda. Soil cores dosed with effluents to which caustic soda had been added, in concentrations well below those expected from a typical "cleaning" dose, caused immediate clogging and accompanying damage to soil structure. Similar, although less dramatic, results were demonstrated using potassium hydroxide. Sodium hydroxide is indeed used as a dispersing agent in soil textural analysis to destroy structure and reduce the sample to its textural elements. When so dispersed soil becomes an impermeable mass.

Changes in Living Habits:

Changes in living habits bring up questions of their effect on the sewage disposal system. Current questions concern the effect of ground garbage,

detergents, brine waste from regeneration of home water softeners, and various proprietary "aids" being offered in this field.

Ground garbage represents an additional solids load, for which either the storage function of the tank must be expanded to provide for the increased rate of accumulation, or cleanings must be made at more frequent intervals. We surveyed a number of systems in the field not long ago, including installations receiving ground garbage waste, and found that there is at least 50 per cent average increase in sludge plus scum accumulations, as compared with tanks not receiving ground garbage in the group. On the basis of what information there is the 50 per cent increase in total tank capacity recommended by the Joint Committee on Rural Sanitation for installations receiving ground garbage appears to be a reasonable precaution.

As far as the soil is concerned, there is evidence from the laboratory studies that septic tanks receiving ground garbage will require larger absorption fields. Soil cores, ranging from silty clay to rather heavy clay, were dosed with effluents from tanks receiving ground garbage and sewage, and sewage only, as a control. Cores receiving the garbage-sewage effluent clogged more rapidly than those receiving the sewage effluent, both on a time, and solids-for-solids basis. The additional soil area required for the garbage-sewage effluent treated cores, to equalize the clogging rates, would be roughly 25 to 35 per cent. The recent examination of systems in the field indicates that there is more organic matter in soil samples from systems receiving ground garbage than from those not receiving garbage. Further information will become available on this when the analysis is complete. On the basis of what is now known, I feel that an increase of 50 per cent in design absorption field size would be a reasonable precaution against failure due to inclusion of ground garbage.

The effect of detergent use in the home, on the individual sewage disposal system is being studied. Thus far, bottle anaerobic digestion experiments and a full size tank experiment using one common anionic detergent in concentrations of average use indicates only slight interferance with septic tank performance.

Concerning the effect of another anionic detergent on soil absorption systems, studies in which detergent and soap respectively were added to tank effluents, indicated no differences in clogging tendencies other than those associated with differences in the amount of suspended solids. Similar studies using tap water suspensions of grease and soap, and grease and detergent did show differential clogging. There was immediate tendency for the soap-grease suspensions to cause greater clogging than the detergent-grease suspensions. Increasing quantities of grease in the soap suspensions caused slight increases in clogging, but the quantities of grease in the detergent suspension showed no apparent correlation with clogging. Recent experiments in which wash waters from a home washer, using soap one week and detergent the next, were applied to laboratory soil cores, indicated no differences in clogging rates on either a time, or solids-for-solids basis. However, there was evidence of some increased damage to soil structure under detergent dosage, which may cause increased clogging from a long time viewpoint. Dosage of soil cores with effluent from a tank receiving sewage and brine waste from simulated softener regeneration indicated no short time damage to percolation rates as compared with normal effluent, but there was some damage to soil structure, which again may be important from a long time viewpoint. Field examinations are to be undertaken on this later.

Questions on additives claimed to "condition," "start," or even "clean" tanks come up frequently. Experiments at Cincinnati, using brewers' yeast, and other reported using bakers' yeast, indicate that yeast has no merit as a starter. As I have already pointed out, some of the so-called cleaners on the market contain caustic soda which can be damaging to the soil system and damaging to septic tank performance as well. Currently there seems to be considerable promotion of additives purported to contain enzymes and bacterial cultures, for which various claims are made. Although there may be possibilities for "starters" here, the necessity for additives after digestion is started is not evident. As you know, ripe sludge is an adequate starter; well rotted barnyard manure has also been used for this purpose.

A reasonably well-designed and operated septic tank needs no extra props. If inadvertent discharge of interfering materials has upset tank action, or if the tank has reached sludge storage capacity, the simplest and safest servicing procedure, considering the protection of the soil absorption system, is to pump out the tank.

In closing, I should like to emphasize a few thoughts which should be kept in mind in dealing with household "septic tank systems." The first is that the septic tank is not a disposal system of itself, but is an important unit of a process in which the objective is the disposal of a large amount of waste liquid mostly into the soil. Soil, for waste disposal purposes, is a sensitive medium, not only sensitive to the heavy liquid loadings usually placed on it, but susceptible also to damage from abnormal changes in the waste being applied to it. We should keep this in mind, not only in considering septic tank design and operating factors,

but also in connection with servicing procedures. The second thought is that while the development of factual information is of fundamental importance, it will fall short of its purpose if it is not applied effectively in the field; that is, incorporated into the design, installation, operation and servicing of each individual installation.